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William Janklow, Governor

DEPARTMENT OF WATER AND NATURAL RESOURCES
Warren R. Neufeld, Secretary

GEOLOGICAL SURVEY
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GROUND WATER STUDY FOR THE SOUTH LINCOLN RURAL WATER SYSTEM

by

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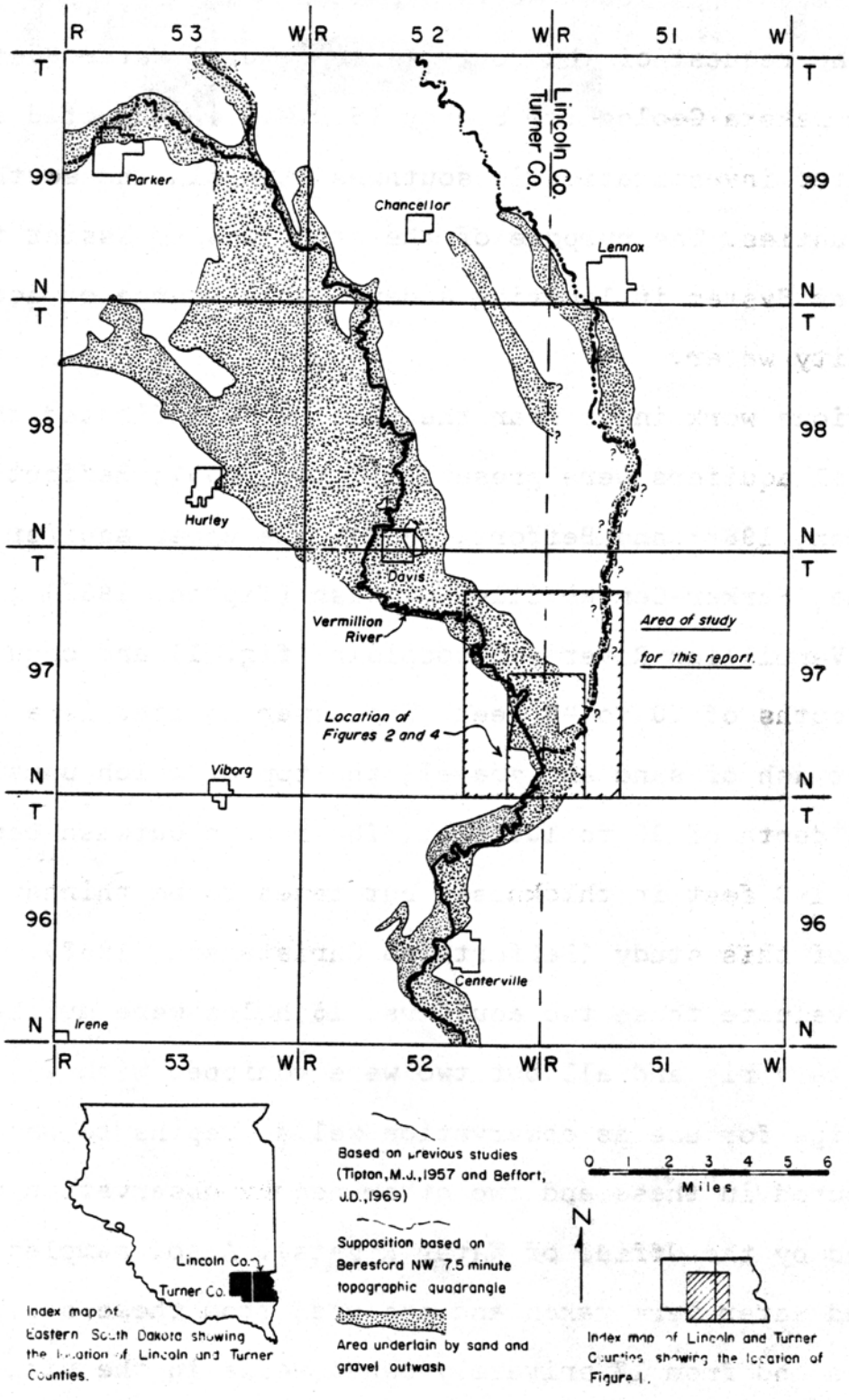
GENERAL INFORMATION

At the request of the South Lincoln Rural Water System, the South Dakota Geological Survey (S.D.G.S.) conducted a ground-water investigation in southwest Lincoln and southeast Turner Counties. The purpose of the study was to assist the Rural Water System in locating a dependable source of acceptable quality water.

Previous work in or near the study area indicated that two glacial aquifers were present (Tipton, 1957; Beffort and Christensen, 1968; and Beffort, 1969). The upper aquifer, termed the 'Parker-Centerville' Outwash (Tipton, 1957) trends down the Vermillion River's floodplain (fig. 1) and occurs between depths of 10 to 40 feet. The lower aquifer is a buried outwash of sand and gravel, the top of which usually lies at a depth of 90 to 100 feet. The buried outwash ranges from 0 to 140 feet in thickness, but tends to be thinner in the area of this study (Beffort and Christensen, 1968).

To evaluate these two aquifers, 15 holes were drilled with a rotary rig and all but two were equipped with 2-inch plastic pipe for use as observation wells. Depths to water were measured in these and two other nearby observation wells (monitored by the Office of Water Rights). Also, samples of the ground water were taken and analyzed from these observation wells and from 17 privately owned wells in the vicinity.

The lithologic logs from the Survey's drilling are shown in Appendix A. Figure 2 shows the locations of the observation wells and the thickness of the shallow aquifer at each location.



Index map of Eastern South Dakota showing the location of Lincoln and Turner Counties.

Based on previous studies (Tipton, M.J., 1957 and Beffort, J.D., 1969)

Supposition based on Beresford NW 7.5 minute topographic quadrangle

Area underlain by sand and gravel outwash

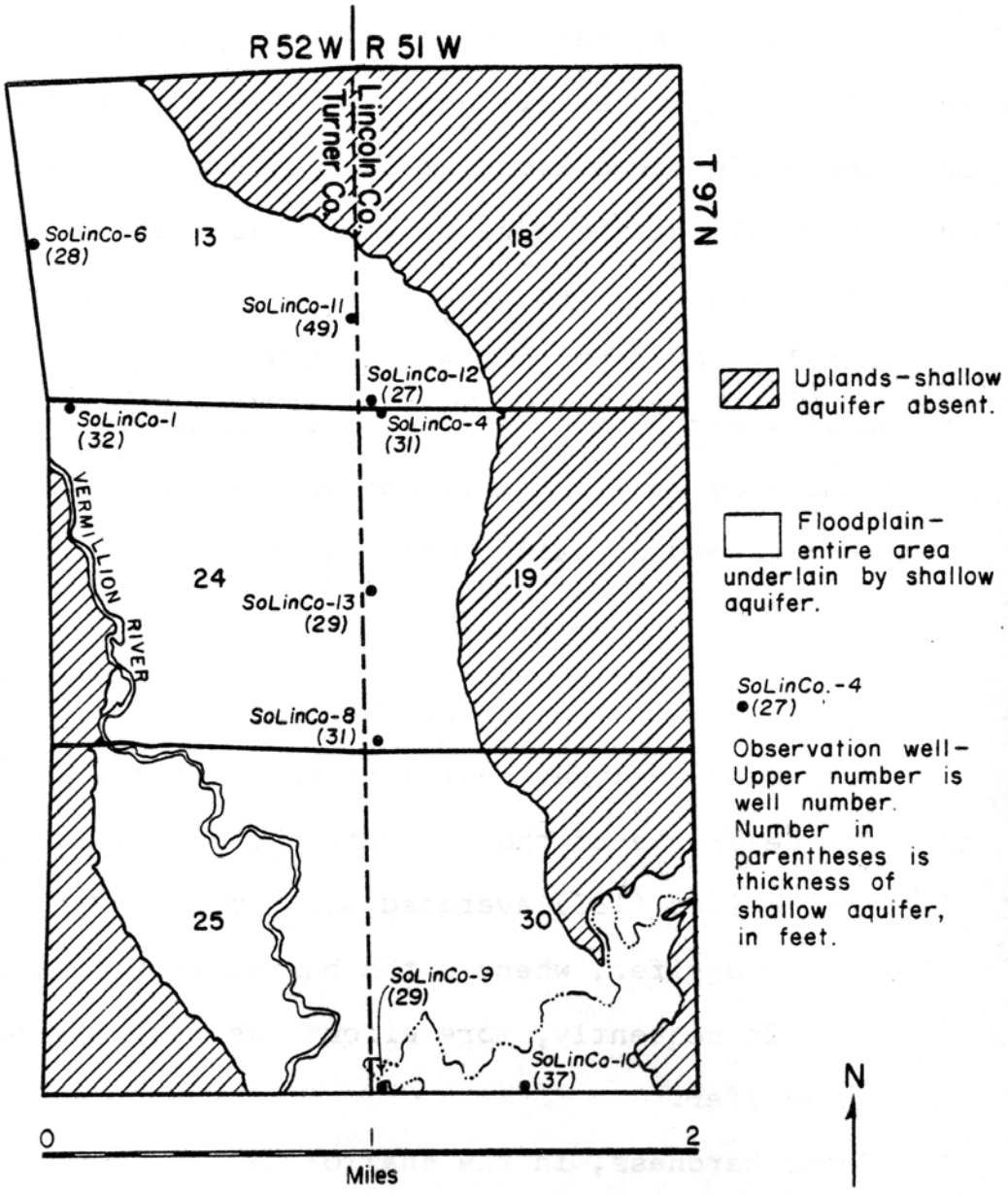
0 1 2 3 4 5 6
Miles

N

Index map of Lincoln and Turner Counties showing the location of Figure 1.

FIGURE 1 Map Showing Areal Extent of the 'Parker - Centerville' Outwash and the Area of Study

Figure 2



Map showing the location of South Dakota Geological Survey observation wells in the shallow aquifer.

The ground water's chemical character is summarized in tables 1 and 2. Table 1 is divided so as to show the various water quality values for the observation wells monitoring either the shallow or the buried aquifers. Table 2, on the other hand, summarizes the water quality in privately owned wells in the study area. These analyses are grouped so as to show the differences among wells at the center of the shallow aquifer, wells at the edge of the shallow aquifer, wells into the buried aquifer, and deeper wells into the Dakota Sandstone.

Finally, a graph showing the quality differences between the shallow and buried aquifer is shown as figure 3. It is accompanied by a water table contour map which indicates the direction of ground-water movement in the shallow aquifer (fig. 4).

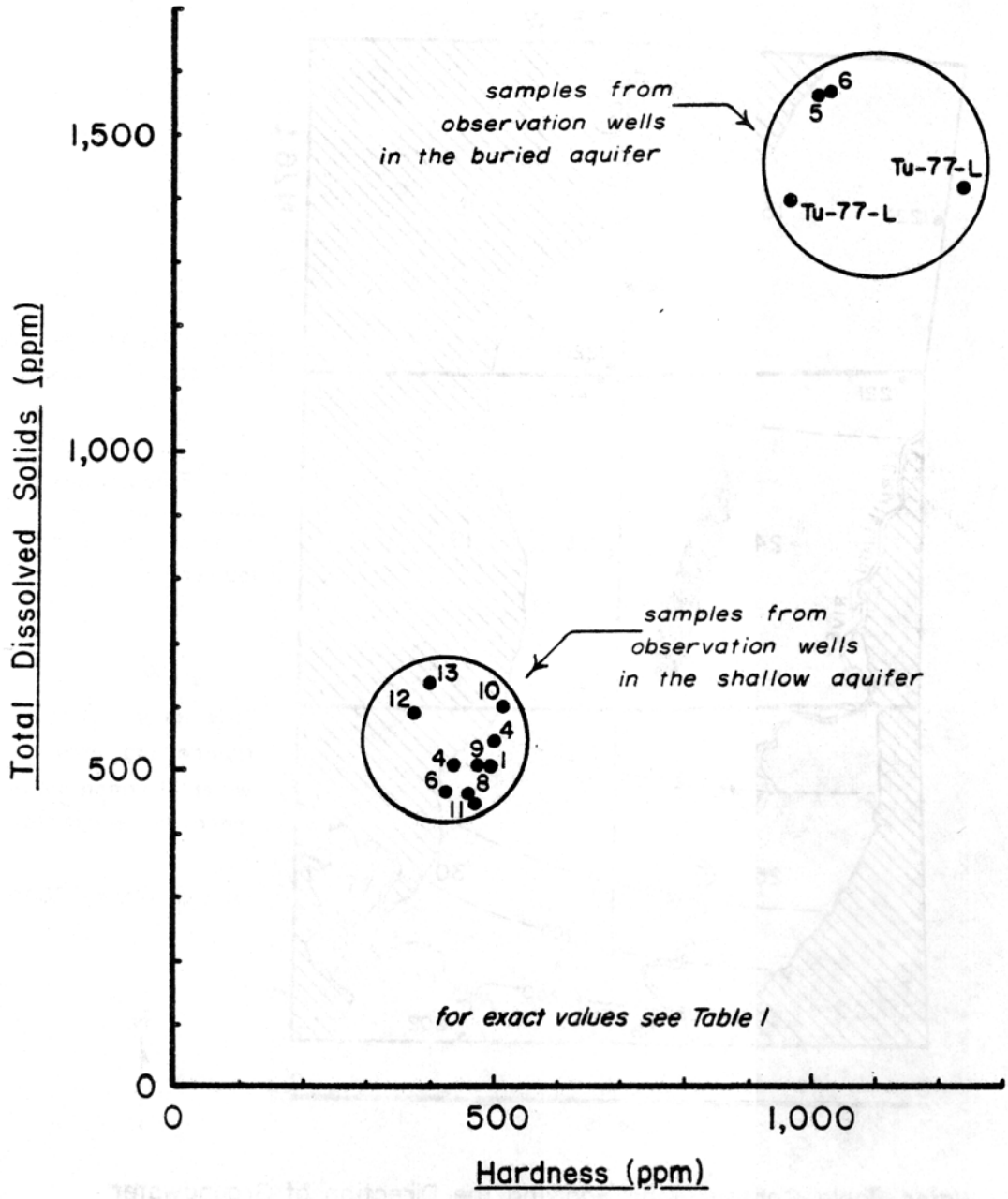
RESULTS

The water analyses indicated that the shallow aquifer is the most desirable of the two water bearing units. The total dissolved solids (TDS) averaged 523 parts per million (ppm) in the shallow aquifer, whereas the buried aquifer averaged about 1550 ppm. Consequently, more effort was made to examine the shallow aquifer.

Total hardness, in the shallow aquifer, was found to average 457 ppm (or 26.7 grains) although it ranges from 374 to 517 ppm (or from 21.8 to 30.2 grains).

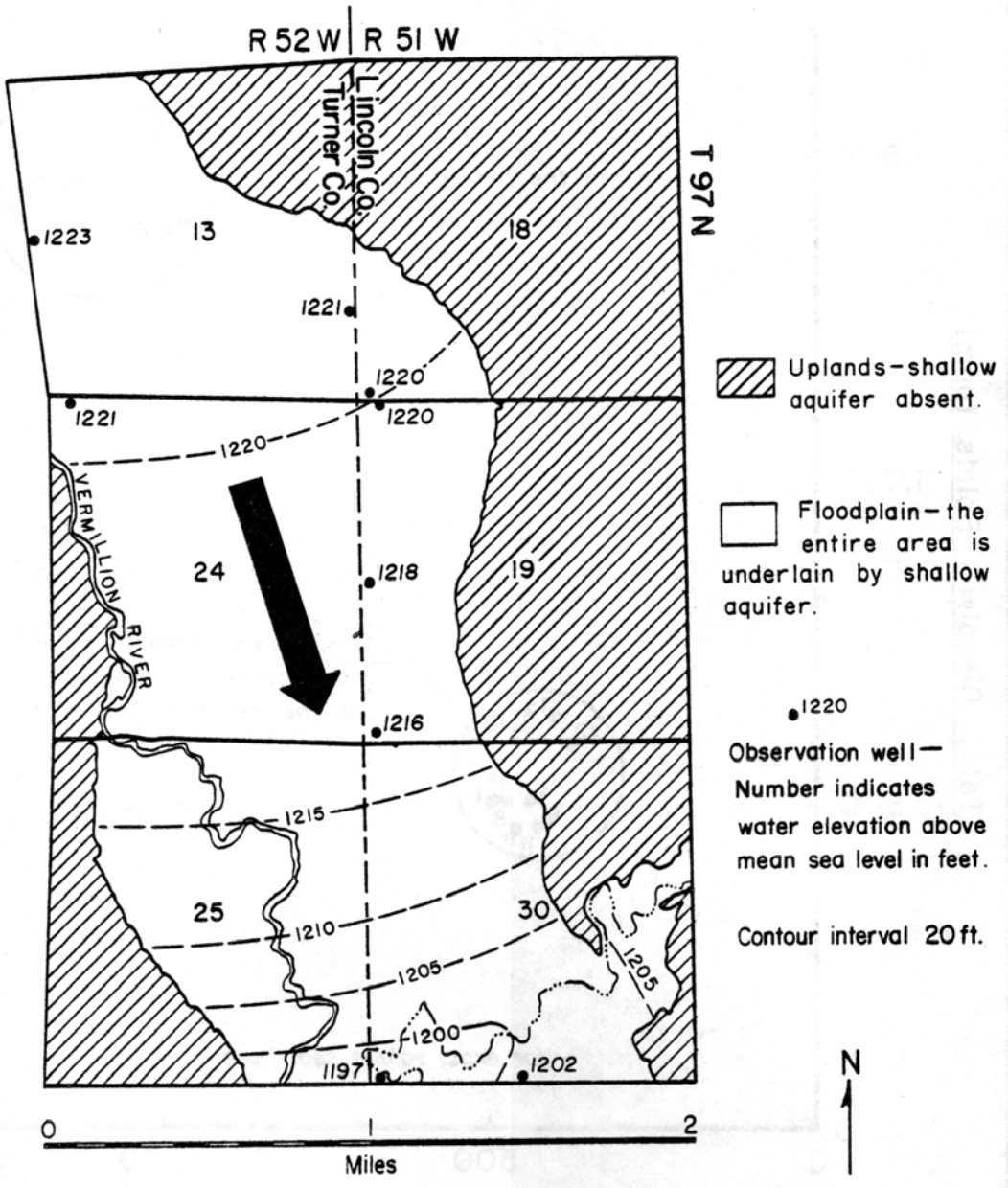
The shallow aquifer's principle limitation, in terms of water quality, is caused by the fairly high concentrations of iron and manganese. The iron concentrations averaged about

Figure 3



Graph Showing Quality Differences Between the Shallow and Buried Aquifers

Figure 4



Water Table Contour Map Showing the Direction of Groundwater Movement in the Shallow Aquifer.

2.0 ppm although they may be somewhat less. The qualifications of the preceding statement is based upon a noted difference in iron values after sampling techniques were changed (see SoLinCo-12 and 13 in table 1). Manganese was observed to average 1.9 ppm in the shallow aquifer.

It was observed that the selenium concentrations in some private wells exceeded the drinking water standards.

The shallow aquifer was observed, in all cases, to be completely saturated. The average thickness for this water bearing unit is about 33 feet, although it ranges in thickness from 28 to 49 feet.

RECOMMENDATIONS

After the Rural Water System has reached agreements with the owners of specific parcels of land overlying the shallow aquifer, plans should be formulated to accomplish the following goals.

Plans should be made to drill additional holes on the property that is ultimately selected so that additional testing of the aquifer's grain size distribution can be made. Accurate samples should be collected at regular intervals so that the proper length and screen size openings can be chosen. The grain size distribution can also be used so that the proper gravel pack can be designed.

A pump test should be conducted near the Rural Water System's future well field so that the aquifer's hydrologic parameters can be established (transmissivity, storage coeffi-

cient, and permeability). The South Dakota Geological Survey is available to supervise such a test or tests. It is recommended that the pump test be run for at least 72 hours and that the well's recovery also be monitored. This information is needed so that the optimum pumping rate and well spacing can be determined. Water samples should also be collected and preserved at regular intervals during the test.

Before drilling any production wells, the Rural Water System should contact the South Dakota Office of Water Rights so that the water rights can be secured. Likewise, the South Dakota Office of Water Quality should be contacted so that the biological and chemical suitability of the aquifer can be approved.

TABLE 1. Summary of the ground-water's chemical character

Well Ident.	Parts Per Million											ppb[1]
	Calcium	Sodium	Magnesium	Iron	Manganese	Chloride	Nitrate Nitrogen	Sulfate	Hardness $CaCO_3$	Conductivity	Total Dissolved Solids	Selenium
A	---	---	---	0.3[2]	0.05[2]	250[2]	10[3]	250[2]	----	----	500[2]	10[3]
Water analyses from the shallow aquifer												
SoLinCo- 1	120	23	48	1.4	1.9	2	-0.5	150	496	745	508	2.7
SoLinCo- 4	120	29	50	2.4	1.6	5	-0.5	180	504	720	548	1.4
SoLinCo- 4	100	18	46	2.4	1.3	2	-0.5	240	438	780	504	0.2
SoLinCo- 6	108	33	39	3.8	2.15	2	-0.5	175	429	720	464	0.7
SoLinCo- 8	120	27	39	2.25	4.0	4	-0.5	135	459	675	468	0.7
SoLinCo- 9	120	36	43	3.3	2.65	3	-0.5	165	475	690	504	1.2
SoLinCo-10	130	44	47	1.3	1.8	13	-0.5	230	517	820	600	1.5
SoLinCo-11	120	36	42	2.0	1.0	3	-0.5	200	471	700	448	3.3
SoLinCo-12*	89	31	37	-0.05	1.19	-2	-0.5	180	374	820	590	---
SoLinCo-13*	96	37	39	0.9	1.23	4	-0.5	190	399	880	640	---
Mean	112	32	43	2.0	1.9	3.8	-0.5	184	457 (26.7 grains)	755	528	---
Water analyses from the buried aquifer												
SoLinCo- 2	180	51	52	3.85	2.25	3	-0.5	400	662	1120	860	0.7
SoLinCo- 5	275	105	80	4.5	2.2	11	1.0	870	1013	1780	1556	0.3
SoLinCo- 5	290	110	76	4.1	2.0	12	-0.5	950	1034	1800	1560	0.0
Tu-77-L (Water Rights)	340	105	95	2.5	2.9	30	-0.5	650	1237	1550	1410	0.9
Tu-77-L (Water Rights)	230	150	74	1.7	2.8	24	-0.5	990	877	1800	1583	0.6
Mean	253	104	75	3.3	2.4	16	-0.5	772	965 (56.4 grains)	1610	1395	---
Water analyses from the Vermillion River												
SE¼SE¼SE¼SE¼ sec. 11, T97N, R52W	148	40	63	0.09	0.35	16	-0.5	450	627 (36.7 grains)	1010	860	---

- Less than

* Filtered sample may have improved accuracy of iron determination

[1]Parts per billion

Sample A:

[2]Proposed National Secondary Drinking Water Regulations, March 31, 1977 (recommended limits)

[3]National Interim Primary Drinking Water Regulations, December 24, 1975 (enforceable limits)

TABLE 2 - Summary of water quality found in nearby privately owned wells

Well Ident.*	Parts Per Million											ppb[1]
	Calcium	Sodium	Magnesium	Iron	Manganese	Chloride	Nitrate Nitrogen	Sulfate	Hardness $CaCO_3$	Conductivity	Total Dissolved Solids	Selenium
A	---	---	---	0.3[2]	0.05[2]	250[2]	10[3]	250[2]	----	----	500[2]	10[3]
Private wells finished in the shallow aquifer located on floodplain on Vermillion River												
C. Eide	111	13	41	4.7	1.6	0	-0.5	240	445	705	536	1.0
D. Landsman	95	15	43	3.1	0.75	0	-0.5	180	413	730	404	0.2
L. Voog	107	43	57	-0.05	0.55	16	0.8	325	500	860	640	28.1
A. Weeg	133	32	87	-0.05	-0.05	55	12.7	290	689	1120	844	25.7
Mean	112	26	57	-2.0	-0.74	18	3.6	259	512 (29.9 grains)	854	606	----
Private wells finished in the shallow aquifer located at extreme edge of floodplain												
K. Ellis	196	93	69	5.5	1.5	2	-0.5	840	772	1440	1224	0.0
B. Landsman	185	45	122	-0.05	-0.05	15	1.0	760	962	1510	1264	8.7
T. Snoozy	225	78	190	-0.05	-0.05	79	15.0	1260	1416	2370	2056	37.1
Mean	202	72	127	-1.9	-0.5	32	5.5	953	1050 (61.4 grains)	1773	1515	----
Private wells not tapping the shallow aquifer; finished either in the buried outwash or glacial till												
E. Bergstrom	280	111	75	10	1.65	11	-0.5	900	1005	1600	1568	1.1
A. Christofferson	290	127	32	0.12	1.45	32	-0.5	840	854	1610	1436	0.0
J. Groseth	190	100	52	5.5	2.0	23	-0.5	690	687	1290	1084	4.2
E. Lounsberry	265	188	135	10	2.1	3	-0.5	1452	1215	2350	2088	1.6
N. Payson	225	235	70	10	2.35	3	-0.5	1380	848	2080	1832	0.3
E. Smit	175	90	50	1.1	0.7	20	2.8	530	641	1170	1012	0.7
Mean	238	142	69	6.1	1.7	15	-0.9	965	875 (51.1 grains)	1683	1503	----
Private wells reaching into the bedrock; that is, finished in the Dakota Sandstone (Cretaceous)												
V. Anderson	195	68	70	2.1	0.07	6	-0.5	570	773	1280	1120	0.5
K. Falk	135	82	58	0.2	-0.05	10	3.6	450	575	1280	868	0.2
D. Johnke	64	80	33	8	-0.05	8	-0.5	265	295	860	504	0.6
M. Nelson	90	100	35	10	0.06	7	3.2	387	367	1060	688	0.7
Mean	121	83	49	5.1	-0.06	7.8	-2.0	418	502 (29.3 grains)	1120	790	---

- Less than
* Location of owner's well is shown in Appendix B
[1]Parts per billion
Sample A:
[2]Proposed National Secondary Drinking Water Regulations, March 31, 1977 (recommended limits)
[3]National Interim Primary Drinking Water Regulations, December 24, 1975 (enforceable limits)

TABLE 3 - Summary of water levels

Water table elevations
(the shallow aquifer)

Well Iden.	Casing top elevation (ft. above msl)	Water table elevations	
		June 7, 1978	August 11, 1978
1	1228.27	1221.77	1221.52
4	1225.48	1219.68	1220.00
6	1229.96	-------	1223.63
7	1225.43	1220.43	1220.93
8	1221.20	1216.40	-------
9	1206.96	1197.09	-------
10	1208.23	1202.73	-------
11	1226.31	-------	1220.98
12	1227.25	-------	1220.17
13	1223.08	-------	1218.46

Estimated hydraulic gradient = 3.2 ft/mile
(based on obs. wells 4 and 8)

Elevation of piezometric surface
(the buried aquifer)

Well Iden.	Casing top elevation (ft. above msl)	Piezometric surface's elevation	
		June 7, 1978	August 11, 1978
2	1228.57	1206.57	1205.15
3	1246.02	1204.52	-------
5	1225.52	1205.77	1204.23

REFERENCES

Beffort, J. D., 1969, Ground-water investigations for the city of Lennox: South Dakota Geol. Survey Special Report 46.

Beffort, J. D., and Christensen, C. M., 1968, Ground-water supply for the city of Viborg: South Dakota Geol. Survey Special Report 43.

Tipton, M. J., 1957, Geology and hydrology of the Parker-Centerville Outwash: South Dakota Geol. Survey Rept. Inv. 82.

APPENDIX A: LOGS OF HOLES DRILLED FOR THIS STUDY

Format of information

Test Hole Number (Observation Well Identification)
Location:
Date Drilled:
Elevation: (Type of Measurement)
(I) = Elevation of casing top made by surveying instrument
(T) = Elevation of ground level estimated from 7½ minute topographic maps

Test Hole 1 (SoLinCo-1)
Location: NW¼NW¼NW¼NW¼ sec. 24, T. 97 N., R. 52 W.
Date Drilled: May 22, 1978
Elevation: 1228.27 (I)

0- 1	Topsoil, black, clayey
1- 6	Clay, brown, silty
6- 40	Gravel, with medium to coarse sand

* * * *

Test Hole 2 (SoLinCo-2)
Location: NW¼NW¼NW¼NW¼ sec. 24, T. 97 N., R. 52 W.
Date Drilled: May 23, 1978
Elevation: 1228.57 (I)

0- 2	Topsoil, black, clayey
2- 16	Clay, brown
16- 40	Sand, very coarse, also gravel increasing with depth
40- 81	Till, medium gray
81-120	Gravel, fine, with very coarse sand

* * * *

Test Hole 3 (SoLinCo-3)
Location: NW¼NW¼NW¼NW¼ sec. 20, T. 97 N., R. 51 W.
Date Drilled: May 23, 1978
Elevation: 1246.02 (I)

0- 2	Topsoil, black, clayey
2- 23	Clay, yellow-brown, sandy with gravel (weathered till?)
23-128	Till, medium gray, gravelly between 58 feet and 64 feet
128-139	Gravel, fine
139-157	Till, medium gray

* * * *

Test Hole 4 (SoLinCo-4)
Location: NW¼NW¼NW¼NW¼ sec. 19, T. 97 N., R. 51 W.
Date Drilled: May 23, 1978
Elevation: 1225.48 (I)

0- 1	Topsoil, black, clay
1- 9	Clay, brown to black
9- 37	Gravel, fine, with very coarse sand

* * * *

Test Hole 5 (SoLinCo-5)
Location: NW¼NW¼NW¼NW¼ sec. 19, T. 97 N., R. 51 W.
Date Drilled: May 24, 1978
Elevation: 1225.52 (I)

0- 2	Topsoil, black, clay
2- 10	Clay, brown to black
10- 41	Sand, gray, very coarse, with some fine gravel
41-121	Till, medium gray
121-135	Till, medium gray, gravelly
135-157	Gravel, medium to coarse (¼ to ½ inch), thin clay lenses

* * * *

Test Hole 6 (SoLinCo-6)
Location: NW¼NW¼NW¼SW¼ sec. 13, T. 97 N., R. 52 W.
Date Drilled: May 24, 1978
Elevation: 1229.96 (I)

0- 2	Topsoil, black, clayey
2- 9	Clay, black
9- 26	Sand, medium to coarse
26- 37	Gravel, fine, with coarse and very coarse sand

* * * *

Test Hole 7 (SoLinCo-7)
Location: SE¼SE¼NE¼SE¼ sec. 13, T. 97 N., R. 52 W.
Date Drilled: May 25, 1978
Elevation: 1225.43 (I)

0- 1	Topsoil, black, sandy clay
1- 63	Gravel, with alot of coarse and very coarse sand
63- 68	Sand, medium to coarse
68- 87	Till, medium gray

* * * *

Test Hole 8 (SoLinCo-8)
Location: SW¼SW¼SW¼SW¼ sec. 19, T. 97 N., R. 51 W.
Date Drilled: May 25, 1978
Elevation: 1221.20 (I)

0- 2	Topsoil, black, clayey
2- 9	Sand, brown, fine to coarse
9- 18	Clay, dark brown to black, sandy
18- 49	Sand, very coarse, some fine gravel
49- 57	Till, medium gray

* * * *

Test Hole 9 (SoLinCo-9)
Location: SW¼SW¼SW¼SW¼ sec. 30, T. 97 N., R. 51 W.
Date Drilled: May 26, 1978
Elevation: 1206.96 (I)

0- 14	Clay, dark brown, silty
14- 16	Sand, medium to fine
16- 43	Gravel, fine, with very coarse sand
43- 47	Till, medium gray

* * * *

Test Hole 10 (SoLinCo-10)
Location: SE¼SE¼SE¼SW¼ sec. 30, T. 97 N., R. 51 W.
Date Drilled: May 26, 1978
Elevation: 1208.23 (I)

0- 15	Clay, dark brown, slightly silty
15- 52	Gravel, with granules, and medium to very coarse sand
52- 57	Till, brownish gray

* * * *

Test Hole 11 (SoLinCo-11)
Location: NE¼NE¼SE¼SE¼ sec. 13, T. 97 N., R. 52 W.
Date Drilled: June 23, 1978
Elevation: 1226.31 (I)

0- 1	Topsoil, brown, silty
1- 7	Clay, yellow brown, silty, some pebbles
7- 56	Gravel, medium, also medium to very coarse sand
56- 58	Till, medium gray

* * * *

Test Hole 12 (SoLinCo-12)
Location: SW¼SW¼SW¼SW¼ sec. 18, T. 97 N., R. 51 W.
Date Drilled: July 5, 1978
Elevation: 1227.25 (I)

0- 1	Topsoil, black
1- 10	Clay, black, very silty
10- 37	Gravel, fine (1/8 to 1/4 inch), also coarse to very coarse sand
37- 47	Till, medium gray

* * * *

Test Hole 13 (SoLinCo-13)
Location: NW¼NW¼NW¼SW¼ sec. 19, T. 97 N., R. 51 W.
Date Drilled: July 12, 1978
Elevation: 1223.08 (I)

0- 1	Topsoil, black
1- 14	Clay, black to brown, slightly sandy (very fine)
14- 43	Sand, very coarse, some ¼-inch gravel
43- 48	Till, gray

* * * *

Test Hole 14
Location: NE¼SE¼SE¼SE¼ sec. 13, T. 97 N., R. 52 W.
Date Drilled: June 23, 1978
Elevation: 1225 (T)

0- 1	Topsoil, black
1- 7	Clay, yellow brown, sandy
7- 48	Gravel, medium, also medium to very coarse sand
48- 57	Till, medium gray
57- 71	Gravel, medium, also medium to very coarse sand
71- 78	Till, medium gray

* * * *

Test Hole 15
Location: NE¼NE¼NE¼NW¼ sec. 19, T. 97 N., R. 51 W.
Date Drilled: July 12, 1978
Elevation: 1232 (T)

0- 8	Sand, yellow brown, fine, limestone fragments appear and probably are road aggregate
8- 25	Sand, yellow brown, very coarse, some fine gravel
25- 30	Sand, gray, very coarse, some small gravel
30-130	Till, medium gray, sand lense between 56 feet and 72 feet, sand lense between 83 feet and 87 feet
130-147	Sand, gray, fine to medium

* * * *

APPENDIX B: Locations of water samples

Government wells sampling the shallow aquifer

Well identification or controller	Legal location
SoLinCo- 1 (SDGS)	NW¼NW¼NW¼NW¼ sec. 24, T. 97 N., R. 52 W.
SoLinCo- 4 (SDGS)	NW¼NW¼NW¼NW¼ sec. 19, T. 97 N., R. 51 W.
SoLinCo- 6 (SDGS)	NW¼NW¼NW¼SW¼ sec. 6, T. 97 N., R. 52 W.
SoLinCo- 8 (SDGS)	SW¼SW¼SW¼SW¼ sec. 19, T. 97 N., R. 51 W.
SoLinCo- 9 (SDGS)	SW¼SW¼SW¼SW¼ sec. 30, T. 97 N., R. 51 W.
SoLinCo-10 (SDGS)	SE¼SE¼SE¼SW¼ sec. 30, T. 97 N., R. 51 W.
SoLinCo-11 (SDGS)	NE¼NE¼SE¼SE¼ sec. 13, T. 97 N., R. 52 W.
SoLinCo-12 (SDGS)	SW¼SW¼SW¼SW¼ sec. 18, T. 97 N., R. 51 W.
SoLinCo-13 (SDGS)	NW¼NW¼NW¼SW¼ sec. 19, T. 97 N., R. 51 W.

Government wells sampling the buried aquifer

SoLinCo- 2 (SDGS)	NW¼NW¼NW¼NW¼ sec. 24, T. 97 N., R. 52 W.
SoLinCo- 5 (SDGS)	NW¼NW¼NW¼NW¼ sec. 19, T. 97 N., R. 51 W.
Tu-77-L (Water Rights)	SW¼SW¼SW¼SW¼ sec. 1, T. 97 N., R. 52 W.

Private wells on Vermillion River floodplain (in shallow aquifer)

C. Eide	NE¼SW¼SW¼ sec. 11, T. 97 N., R. 52 W.
D. Landsman	SW¼NW¼SW¼ sec. 31, T. 97 N., R. 51 W.
L. Voog	NW¼NW¼SW¼ sec. 18, T. 97 N., R. 51 W.
A. Weeg	NE¼NE¼SE¼NW¼ sec. 19, T. 97 N., R. 51 W.

Private wells at extreme edge of floodplain (in shallow aquifer)

K. Ellis	NE¼NE¼SE¼SE¼ sec. 30, T. 97 N., R. 51 W.
B. Landsman	NE¼NE¼NE¼NW¼ sec. 30, T. 97 N., R. 51 W.
T. Snoozy	C SE¼SW¼ sec. 19, T. 97 N., R. 51 W.

Private wells finished in either the buried aquifer or till

E. Bergstrom	C SE¼SE¼ sec. 12, T. 97 N., R. 52 W.
A. Christofferson	SE¼SE¼SW¼SW¼ sec. 7, T. 97 N., R. 51 W.
J. Groseth	SW¼SE¼SW¼ sec. 12, T. 97 N., R. 52 W.
E. Lounsberry	SW¼NW¼SE¼ sec. 19, T. 97 N., R. 51 W.
N. Payson	NE¼NE¼SE¼ sec. 31, T. 97 N., R. 51 W.
E. Smit	C NW¼SW¼ sec. 12, T. 97 N., R. 52 W.

Private wells finished in the Dakota Sandstone

V. Anderson	NE¼SW¼SE¼SE¼ sec. 18, T. 97 N., R. 51 W.
K. Faulk	SW¼NW¼SW¼SW¼ sec. 16, T. 97 N., R. 51 W.
D. Johnke	SE¼SW¼SW¼SE¼ sec. 20, T. 97 N., R. 51 W.
M. Nelson	SE¼NE¼NE¼ sec. 29, T. 97 N., R. 51 W.